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Phase Transformations in Materials

Phase Transformations in Materials. Edited by Gernot Kostorz
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Phase Transformations in Materials

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To the memory of Peter Haasen
(1927–1993)

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Preface

In 1991, the late Peter Haasen, who had set out to edit a comprehensive treatment of "Materials Science and Technology" together with Robert W. Cahn and Edward J. Kramer, a very successful series of up-to-date coverages of a broad range of materials topics, wrote the following in a Preface to Volume 5.

"Herewith we proudly present the first volume of this Series, the aim of which is to provide a comprehensive treatment of materials science and technology. The term 'materials' encompasses metals, ceramics, electronic and magnetic materials, polymers and composites. In many cases these materials have been developed independently within different disciplines but are now finding uses in similar technologies. Moreover, similarities found among the principles underlying these various disciplines have led to the discovery of common phenomena and mechanisms. One of these common features, phase transformations, constitutes the topic of this volume and rates among the fundamental phenomena central to the Series. A phase transformation often delivers a material into its technologically useful form and microstructure. For example, the major application of metals and alloys as mechanically strong materials relies on their multi-phase microstructure, most commonly generated by one or more phase transformations."

Peter Haasen, who passed away in 1993, did not live to see the overwhelming success of this volume. A revised edition was planned as early as 1996 and finally, work on the individual chapters began in 1998. Almost all of the original authors agreed to update their earlier work, in many cases they arranged for the participation of younger colleagues who had made major contributions to the field. It is thus with similar pride the present editor submits the second edition of "Phase Transformations" to the scholarly public. It was with some hesitation that he assumed the task of editor, as he did not like giving the impression of plagiarizing a successful work. All the credit for the idea, the original chapter definitions and the selection of the initial authors remains with Peter Haasen. He would certainly have liked to work on a new edition himself and, assuming that he would have judged it timely to accomplish it about ten years after the first edition, this editor tried to help reaching this goal in the original spirit.

Thus, all the chapters kept their original titles. The contents have been thoroughly reedited and updated and reflect the progress in the field up to about the middle of the year 2000. As before, the book starts with the foundations of phase transformations ("Thermodynamics and Phase Diagrams" by A. D. Pelton). The sequence of the following Chapters has been slightly modified. As most of the volume concerns the solid state, Chapter 2 (by H. Müller-Krumbhaar, W. Kurz and E. Brener) is devoted to solidification, a subject of great basic and technological relevance. Chapter 3 by G. E. Murch covers the most important ideas and methods of diffusion kinetics in solids, an indispensible ingredient to many phase transformations. Statistical theories of phase transformations are presented by K. Binder in Chapter 4, featuring phenomenological concepts and computational methods. Diffusion controlled homogeneous phase transformations are treated in Chapter 5 ("Homogeneous Sec-

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ond Phase Precipitation" by R. Wagner, R. Kampmann and P. W. Voorhees) and Chapter 6 ("Spinodal Decomposition" by K. Binder and P. Fratzl), looking at the very complex kinetical aspects of the formation of new phases from the points of view of metastability and instability in an initially homogeneous system. Heterogeneous phase transformations are treated in Chapter 7 ("Transformations Involving Interfacial Diffusion" by G. R. Purdy and Y. Bréchet) while Chapter 8 by G. Inden deals with atomic ordering, mostly involving substitutional alloys and intermetallic phases. Though much progress has been made in elucidating equilibrium ordered states, kinetical aspects are still widely unexplored in this field. Finally, the numerous aspects of diffusionless transformations in the solid state are taken up by L. Delaey (Chapter 9), and a completely new Chapter on the effects of pressure on phase transformations has been provided by M. Kunz (Chapter 10).

In working on this new edition, the editor had great pleasure interacting with the authors, those of the first edition as well as those who joined for the new edition. He is grateful to all of them for their friendly and competent co-operation. Thanks are due to the publisher for expedient support and for the preparation of the subject index.

It is hoped that this book will be useful as a source of reference to active researchers and advanced students; more up-to-date and more detailed than encyclopedic articles, but not as complete and extensive as any monographs. Phase transformations are among the most complex and most versatile phenomena in solid state physics and materials science – and have considerable impact on production and processing technology. The present book should encourage the reader to enter and more deeply appreciate this challenging field.

Gernot Kostorz, Zürich
April 2001

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